

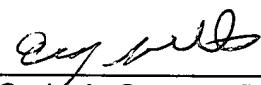
## **REMARKS**

Applicants have amended Claims 1 – 10 and added claims 11-18. The changes are shown with strikethrough for deleted matter and underlining for added matter. No new matter has been added as a result of this amendment.

A substitute specification has been provided. A marked-up copy shows the changes. A claim for priority has been added. No new matter was added.

Applicants respectfully submit that all of the pending claims are in condition for allowance and seek an early allowance thereof. If for any reason the Examiner is unable to allow the application in the next Office Action and believes that a telephone interview would be helpful to resolve any remaining issues, he is respectfully requested to contact the undersigned attorney or agent.

Respectfully submitted,

  
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## HOUSING CUP FOR AN ELECTRONIC COMPONENT WITH INTEGRATED COOLING BODY

### RELATED APPLICATIONS

[0001] The present patent document is a continuation of PCT Application Serial No. PCT/EP2004/052685, filed October 28, 2004, designating the United States, which is hereby incorporated by reference.

### BACKGROUND

#### Field of Invention

[0002] The invention relates present embodiments relate to a housing for an electronic component, substantially comprising a housing cup with an integrated cooling body.

### DISCUSSION OF RELATED ART

[0003] During the operation of electronic components, depending on their specific field of use, sometimes considerable amounts of power can be lost occurs in the form of heat. Higher losses cause increased heat stress. The increased heat stress has a decisive influence on the can shorten the service life of the electronic component. To prevent heat stress, This heat must be dissipated via the housing of the electronic component. The capacity ability of the housing for heat dissipation thus to dissipate heat substantially determines the service life, the specific field of use, and the electrical design of the electronic component.

[0004] By improving heat dissipation features, as a rule the means increased current-carrying carrying capacity or the allowance of higher ambient temperatures can be increased. To reduce heating and e Electronic components,

they are sometimes oversized to reduce heating. However, oversizing electronic components is disadvantageous because of the increased material required to make the parts larger, or tasks in electronic circuits are distributed by means of assemblies

**[0005]** It is also possible to connect the electronic components to one another to a plurality of what as a rule are identical electronic components in order to lower the load of each individual component and increase the cooling surface. For example, capacitors can be connected in parallel to lower the load of each capacitor. However, the parallel connection creates increased number of electronic components and is disadvantageous because of the higher production costs and the increased effort of assembly. This is known particularly from the parallel connection of capacitors. As a result, leads for individual components are reduced while at the same time the cooling surface areas are increased.

**[0006]** Alternatively, To reduce the heat of a housing a cooling body is often secured, particularly by screwing, to secured to the housing of the electronic component by a screwing method. A cooling body is designed to efficiently dissipate the heat created by the electronic component. The heat transfer between the electronic component and the cooling body can be improved still further by means of a with use of heat-conducting foil, known as "Thermopads", as an intermediate layer, or by means of corresponding heat-conducting pastes. However, securing a cooling body to the housings of electronic components also involves increased effort of assembly.

**[0007]** From German Patent DE 198 17 493 C1, discloses an electrolyte capacitor is known, whose housing is provided with a number of cooling fins. The housing of the known capacitor is embodied as a cast aluminum part.

[0008] Housings for electronic components are often stamped formed out in a cylindrical form. For These housings, depending on their internal construction and the type of electronic component, dissipate heat dissipation via the cylindrical base can have decisive importance. This is particularly true for Electronic components with a cylindrical base have in which thea reduced heat-conducting capacity in the radial direction is less, particularly because of their internal construction. -In a cylindrical component, In this case, the an air gap, which in some cases is can be up to several millimeters wide, between the electronic component and the housing can acts as an internal heat resistor and create heat stress.

[0009] However In addition, heat dissipation via the cup base can be comparatively impaired reduced, since there as well, because optimal electrical contact, for the sake of heat dissipation, of between the cup base with and the electronic component isare not sufficient for proper heat dissipation achieved without additional provisions. It is known that for this reason For example, in a capacitor, for instance, thecapacitor, the cathode foil must be made to protrude from the lower end of the coil in order to , so that greatly improved the heat connection of between the coil to theand the cup base is accomplished on one side. Thus, it is of importance to dissipate heat for components with reduced heat-conducting capacity.

[0010] Oversizing electronic components is disadvantageous because of the increased material required; the parallel connection of an increased number of electronic components is also disadvantageous because of the higher production costs and the increased effort of assembly. Retroactively securing a cooling body to the housings of electronic components also involves comparatively great effort of assembly.

## SUMMARY

[0011] The present embodiments are directed to a housing cup for an electronic component with an integrated cooling body which may obviate one or more of problems due to the limitations and disadvantages of the related art.

[0012] This object is attained according to the invention by a housing cup for a A housing cup for an electronic component is formed with a cup base. The cup base is formed into a cooling body that is integral with the housing cup, such as by extrusion, which is produced by extrusion and is characterized in that the cup base is formed into a cooling body that is integral with the housing cup.

[0013] By Integrating the cooling body with the housing cup, allows the current-carrying capacity of the electronic component, compared to a corresponding electronic component with a smooth housing wall, can to be increased substantially. For example, the current-carrying capacity may be increased by more than 100%, depending on the type of electronic component. No substantial additional costs occur in producing the housing cup, especially since because the cooling body is stamped out jointly in the same work step with the stamping of the housing cup. The cooling action of the housing cup is also enhanced by producing it by extrusion. Because of the compaction of the housing material and because of the material structure developed in the course of the flow of material, the heat- conducting capacity of the housing cup is favorably influencedincreased.

[0014] In a preferred versionone embodiment, the cooling body includes a number of protrusions, which protrude from the cup base essentially in the axial direction of the housing cup. In expedient variants, These protrusions are embodied selectivelymay be formed in pin-like, prism-like or lamination-like

form. Various other forms of protrusions can furthermore be used in combination.

[0015] The basic shape of the housing cup is essentially cylindrical. The cylindrical shape of the housing cup has proved advantageous, particularly because of its excellent pressure stability.

[0016] ~~In a further advantageous variant, especially when a plurality of electronic components are connected to one another, In another embodiment off the housing, the cooling body or at least one of its axial protrusions can beis~~ used as a mechanical guide element. This embodiment is particularly beneficial when a plurality of electronic components is connected to one another. This element can advantageously be employed in arrangements in whichwith larger electronic components that have to be connected to one another to form multicomponent assemblies, where because of the particular way the product is used, increased resistance to shock and jarring is necessary.

[0017] ~~An advantageous version is obtained if t~~ The cooling body may be is cooled directly or indirectly by means of a fluid. With direct cooling, the cooling body is bathed directly by the fluid, for example, with such as deionized water. In the indirect variant, the element used for mechanically guiding the electronic component has fluid flowing through it, or the cooling body itself is embodied such that it can be connected to cooling elements, for example, with cooling hoses, or cooling tubules). In this way, This embodiment maximizesum heat removal from the housing surface can be achieved.

[0018] ~~The object is attained in particular by a capacitor especially an~~ An electrolyte capacitor having an embodiment of the housing cup as described above is one type of capacitor. In the capacitor, higher losses occur particularly with the use because of alternating voltage or voltages of increasing waviness,

because of the resultant alternating current or the resultant current of increased waviness, and because of the comparatively higher substitute series resistance. The consumption of the service life of the capacitor and the attendant worsening of its electrical parameters (capacitance) especially are higher and are directly dependent on the heat development in the capacitor. Because of the internal construction of the component, the heat removal via the cup base plays a decisive role in the capacitor, since because, in the radial direction, the heat-conducting capacity is limited because of due to its particular construction. The air gap, up to which may be several millimeters wide, between the coil and the side wall acts as an additional heat resistor.

**[0019]** Still further improved cooling of In another embodiment, the capacitor is cooled is achieved whenever the capacitor winding, comprising two capacitor foils and a dielectric, is wound in such a way that a capacitor foil protrudes from the capacitor winding base, and thus, The cup base formed into the cooling body is electrically connected directly electrically directly to the protruding capacitor foil.

**[0020]** Compared to electrically contacting the capacitor foil with a smooth cup base without an additionally formed cooling body, or a cup base formed into the cooling body without direct electrical contacting of the capacitor foil to the cup base, the heat emission capacity and thus the alternating current load and/or service life of the capacitor can be increased further by multiple times. By disposing the cooling body on the cup based, especially effective heat dissipation is attained, since on the cup base, the thermal contact between the housing cup and the capacitor winding of the capacitor is especially good.

**[0021]** The object is further attained according to the invention by a production method for producing the aforementioned housing cup.

[0022] In this A method will be described, that forms the housing cup of the electronic component, such as by extrusion is produced by extrusion. In the course of the pressing operation of the housing cup, an integrated cooling body is formed into the cup base. The production method of the invention is based on an extrusion method of using a matrix, The matrix is provided which in a base region is provided with the negative shape of the cooling body to be made.

[0023] The advantages attained with the invention are particularly that the current-carrying capacity of the electronic component is increased substantially because of the improvement in heat dissipation to the housing surface and by improving the heat removal from the housing surface, without entailing significant additional expenses for producing the component. The higher current-carrying capacity of the electronic component makes a cost reduction possible in making electronic circuits, especially since the number of electronic components to be connected to one another can be reduced. For the same service life, the electronic component equipped according to the invention is capable of carrying higher current than a conventional one with a smooth cup wall. Conversely, if the load on the electronic component remains the same, a longer service life is attained. The housing cup of the invention is also especially easy to manipulate, especially since the additional effort for attaching cooling bodies can be eliminated.

[0024] The increased heat removal from the housing surface is assured by the integration of a cooling body into the cup base. Preferably in multicomponent assemblies, the heat transport is positively influenced by directly contacting the cooling body with separate air- or fluid-cooled elements. Still another substantial increase in heat dissipation is attained by the direct electrical contacting of the capacitor winding with the cup base.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0025] Exemplary embodiments of the invention will be described further detail below in conjunction with the drawings. Shown in them the drawings are:

[0026] Fig. 1, is in a schematic cross section of, a housing for an electronic component with a housing cup and a cooling body integrated into the cup base;

[0027] Fig. 2 shows, a top view of the cup base and the cooling body that is provided with pin-like protrusions;

[0028] Fig. 3 shows, in a view corresponding to Fig. 2, an alternative embodiment of the cooling body, in which the protrusions are embodied in lamination-like form;

[0029] Fig. 4 shows, a cylindrical capacitor winding, stamped formed out such that the capacitor foil protrudes from the capacitor winding base;

[0030] Fig. 5, is a schematic cross section, of a capacitor comprising a housing as shown in Fig. 1 and a capacitor winding as shown in Fig. 4;

[0031] Fig. 6 shows, a multicomponent assembly for capacitors with indirect cooling.

## DETAILED DESCRIPTION

[0032] Reference will be made in detail to the preferred embodiments, examples of which are illustrated in the accompanied drawings. Wherever possible, elements corresponding to one another are identified by the same reference numerals in all the drawings.

[0033] The housing, schematically As shown in Fig. 1, for an electronic component housing 1 includes a cylindrical housing cup 2, which is closed off with a housing cap 3. In the interior of the housing formed by the housing cup 2

and the housing cap 3 is the electronic component 4, which is electrically contacted by two ~~wirelike terminal contact leadss~~ 5 (wire terminals) that ~~are~~ passed through the housing cap 3.

[0034] The housing cup 2 has a tubular side wall 6. The open end of the housing cup 2, which is closed off by a cup base 7 integrated with the side wall 6, ~~The cup base 7 and the housing cap 3 are on the opposite face ends opposite of the housing cupap 32,~~ ~~by a cup base 7 embodied integrally with the side wall 6.~~ The cup base 7 forms the bottom face of a cooling body 8 and is embodied ~~integratedlly~~ with the housing cup 2. The cooling body 8 ~~further~~ includes a number of protrusions 9, which protrude from the outer surface of the cup base 7 in the axial direction 10 of the housing cup 2 and are spaced apart from one another.

[0035] Figs. 2 and 3, in a view counter to the axial direction 10-of~~on~~ the cup base 7, show two alternative embodiments of the protrusions 9. In Fig. 2, the protrusions 9 are embodied in pin-like form. In Fig. 3, the protrusions 9 have the shape of laminations. In both versions, the cross section through the electronic component housing 1 corresponds to the view in Fig. 1.

[0036] ~~Besides the versions shown in Figs. 2 and 3, t~~The protrusions 9 may also ~~(in a manner not shown)~~ be embodied as prism-like (not shown).

[0037] The housing cup 2 ~~which, includesing~~ the cooling body 8, is produced in a single ~~work~~-step by means of extrusion. This technique is already ~~usual used for producesing~~ a conventional, smooth housing cup for a conventional electrolyte capacitor. ~~For When~~ When embodying forming the cooling body 8, the conventional production method is modified such that the matrix of a pressing device, used for producing the housing cup 2, is provided in a base region with the negative shape of the cooling body 8 to be made. ~~In~~ During the

pressing operation of the housing cup 2, the cooling body 8 is then automatically molded with it.

[0038] Fig. 4 shows a cylindrical capacitor winding 15. The capacitor winding 15 is created by winding up a material composed of at least three layers. One layer forms the cathode foil 12; another layer forms a dielectric made of electrolyte-saturated paper 13; and a third layer forms the anode foil 14. The various layers are located one above the other but not with projection precision. The capacitor winding 15 is ~~stamped outformed~~ such that the cathode foil 12, on a capacitor winding base, has an offset from the paper layer and anode foil. Thus on both sides, ~~T~~the electrolyte-saturated intermediate paper layer 14 insulates the cathode foil 12 and the anode foil 13 from one another.

[0039] The capacitor 16 schematically As shown in Fig. 5, the capacitor 16 includes a cylindrical housing cup 2. The cylindrical shape of the housing cup has proved advantageous, particularly because of its excellent pressure stability. The open end of the cylindrical housing cup 2 which is closed off with a housing cap 3. Located in the interior of the housing formed by the housing cup 2 and the housing cap 3 is the capacitor winding 11, which is electrically contacted by two ~~wirelike terminal contact leadss~~ 5 which passed through the housing cap 3. The interior of the housing 2 and the housing cap, 3 is also filled with an electrolytic fluid F. The capacitor winding base 15, with its protruding capacitor foil, directly contacts the inside of the cup base 7 electrically.

[0040] Fig. 6 schematically shows an arrangement of capacitors 16 according to the invention. The whose cooling bodies 8 of the capacitors 16 are connected in a heat-conducting fashion to a mechanical fastening element 17. The mechanical fastening element 17 comprises heat-conducting material and has conduits through which a fluid flows as a cooling fluid. This embodiment is

particularly beneficial when a plurality of electronic components is connected to one another. This embodiment can advantageously be employed in arrangements with larger electronic components that have to be connected to one another to form multicomponent assemblies, where because of the particular way the product is used, increased resistance to shock and jarring is necessary.

[0041] In an exemplary embodiment (not shown), the cooling body 8 of a capacitor 16 may also be embodied such that it is connected directly to a cooling hose or cooling tube. The cooling body may for instance have a bore, through which a cooling hose or cooling tube is passed, or it may be embodied such that a cooling hose or cooling tube can be fastened to it. With direct cooling, the cooling body is bathed directly by the fluid, for example, with deionized water. In the indirect variant, the element used for mechanically guiding the electronic component has fluid flowing through it, or the cooling body itself is embodied such that it can be connected to cooling elements, for example, with cooling hoses or cooling tubules. This embodiment maximizes heat removal from the housing surface.

[0042] No substantial additional costs occur in producing the housing cup because the cooling body is formed in the same work step with the forming of the housing cup. The cooling action of the housing cup is also enhanced when produced by pressing. Because of the compaction of the housing material and because of the material structure developed in the course of the flow of material, the heat-conducting capacity of the housing cup is favorably influenced.

[0043] In another preferred embodiment, an electrolyte capacitor having a housing cup as described above is used. An electrolyte capacitor normally has a higher loss because of alternating voltage or voltages of increasing waviness, because of the resultant alternating current or the resultant current of increased

waviness, and because of the comparatively higher substitute series resistance.  
The consumption of the service life of the capacitor and the reduction of its  
capacitance are higher and are directly dependent on the heat development in the  
capacitor. Because of the internal construction of the component, the heat  
removal via the cup base plays a decisive role in the capacitor because the heat-  
conducting capacity is limited because of its particular construction, for  
example, the air gap, between the coil and the side wall acts as an additional  
heat resistor and increases heat stress.

**[0044]** While the invention has been described above by reference to various  
embodiments, it should be understood that many changes and modifications can  
be made without departing from the scope of the invention. It is therefore  
intended that the foregoing detailed description be regarded as illustrative rather  
than limiting, and that it be understood that it is the following claims, including  
all equivalents, that are intended to define the spirit and scope of this invention.

## ABSTRACT

According to the invention, A housing of an electronic component with an integrated cooling body is provided. The cup base of the housing is formed as a cooling body. The cooling capacity of an electronic component (4) may be improved with simple means, whereby the electronic component (4) is provided with a housing cup (2), produced by an extrusion method, the cup base (7) of which is formed to give a cooling body (8), integral with the housing cup (2).body and the housing cup are formed integrally by an extrusion method.